REMARKS

The rejection of Claims 1-4 and 7-16 under 35 U.S.C. § 102(b) as anticipated by or, in the alternative, under 35 U.S.C. § 103(a) as obvious over, U.S. 5,424,256 (Yoshimura et al '256) or U.S. 5,369,065 (Yoshimura et al '065), is respectfully traversed. (The term "Yoshimura et al" is used below when applicable to either Yoshimura et al '256 or Yoshimura et al '065).

As recited in above-amended Claim 1, the invention is a wear resistant member, comprising: a ball member consisting essentially of a silicon nitride sintered body;

wherein the silicon nitride sintered body comprises including from 75 to 97% by mass of silicon nitride, from 0.2 to 5% by mass of particles of titanium nitride and from 2 to 20% by mass of a grain boundary phase comprising a Si-R-Al-O-N compound, where R is a rare earth element;

wherein the particles of titanium nitride have a long axis of 0.04 μm or more and 1 μm or less, and at least 80% by volume of the particles of titanium nitride have an aspect ratio in the range of from 1.0 to 1.2,

wherein the ball member has a rolling fatigue life of 400 hr or more when tested with a thrust bearing testing machine, under the conditions of opponent material of a SUJ2 steel plane table provided by JIS G4805, a maximum contact stress of 5.9 GPa, a ball, and a number of rotation of 1200 rpm, and the rolling fatigue life is measured until a surface of the ball member is peeled off.

The present invention relates to a wear resistant, ball member consisting essentially of a silicon nitride excellent in sliding characteristics, in particular rolling fatigue life. The titanium nitride particles exist mainly in the grain boundary phase of the silicon nitride sintered body, thereby reinforcing the grain boundary phase to contribute to an improvement in sliding characteristics, in particular rolling fatigue life of the silicon nitride sintered body.

However, when the particle diameter of the titanium nitride particles is large, or the titanium nitride particles a have a distorted form, the sliding characteristics of the silicon nitride sintered body decline. In particular, the form of the titanium nitride particles affects the rolling fatigue life of the silicon nitride sintered body.

The ball-shaped wear resistant member of the present invention has a rolling fatigue life of 400 hr or more. Such an excellent rolling fatigue life is based on the titanium nitride particles having a long axis in the range from 0.04 to 1 μm and an aspect ratio in the range from 1.0 to 1.2 (at least 80% by volume of particles), and β-Si_3N_4 phase as a main phase of the silicon nitride sintered body.

When the long axis of the titanium nitride particles exceeds 1 μm, the sliding characteristics of the silicon nitride sintered body deteriorate. But the sliding characteristics cannot be improved if the long axis of the titanium nitride particles is too small. As shown in Tables 4 and 5 of the specification, the titanium nitride particles having a long axis in the range of from 0.04 to 1 μm contribute to improvement of the sliding characteristics.

Furthermore, at least 80% by volume of the titanium nitride particles have an aspect ratio in the range of from 1.0 to 1.2. The aspect ratio defines a ratio of long axis to short axis. When the ratio of slim particles of which aspect ratio is more than 1.2 exceeds 20% by volume, anisotropy and fluctuation in the reinforcement of the grain boundary phase occur. Thereby, the rolling fatigue life of the silicon nitride sintered body deteriorates.

When the titanium nitride particles have an aspect ratio in the range of from 1.0 to 1.2, the grain boundary phase can be uniformly reinforced and sliding shock can be effectively relieved. Therefore, the sliding performance such as rolling fatigue life can be markedly improved.

It is clear that the silicon nitride sintered body in the present invention has a β-Si_3N_4 phase, because the silicon nitride sintered body is made by sintering at a temperature in the

range from 1600 to 1900°C, as recited in non-elected Claim 17. At such a range, the silicon nitride raw material powder becomes the β-Si_3N_4 phase.

A silicon nitride sintered body comprising β-Si_3N_4 phase is excellent in sliding characteristics. Furthermore, the silicon nitride sintered body comprises titanium nitride particles existing in the grain boundary phase. With titanium nitride particles having a long axis in the range from 0.04 to 1 μm and an aspect ratio in the range from 1.0 to 1.2, the grain boundary phase can be uniformly reinforced, and sliding shock can be effectively relieved.

Therefore, the rolling fatigue life of the ball-shaped wear resistant member can be markedly improved. That is, the ball-shaped wear resistant member in the present invention has a rolling fatigue life of 400 hr or more. With such a ball-shaped wear resistant member, a rolling bearing member having a long life can be realized.

Yoshimura et al '256 discloses a silicon nitride sintered body comprising dispersed particles of, for example, titanium nitride, having an average particle size of 0.1 μm or less (column 4, lines 64-66), and a strength of 160 kg/mm^2 or higher in terms of a three-point bending strength (Claim 4). Yoshimura et al '256 disclose frictionally sliding parts only generally.

Yoshimura et al '065 discloses a silicon nitride sintered body comprising titanium compound particles, such as titanium nitride particles, which appear to have an average size of 300 nm or less, and having improved bending strength and fracture toughness (Table 2 and column 9, lines 31-36).

However, Yoshimura et al neither disclose nor suggest a ball-shaped silicon nitride sintered body. Nor obviously do Yoshimura et al disclose a ball-shaped wear resistant member having an excellent rolling fatigue life, in particular rolling fatigue life of 400 hr or more. Indeed, Yoshimura et al disclose and suggest nothing about rolling fatigue life.

Nor do Yoshimura et al disclose the form of their respective titanium nitride particles. Yoshimura et al neither disclose nor suggest that at least 80% by volume of their titanium nitride particles have an aspect ratio in the range of from 1.0 to 1.2, as recited in Claim 1. Nor do Yoshimura et al recognize the improvement in rolling fatigue life of the silicon nitride sintered body when operating within this aspect ratio, as detailed in the comparative data of record. As discussed above, Yoshimura et al disclose nothing with regard to improving rolling fatigue life. Rather, Yoshimura et al are concerned primarily with strength and fracture toughness, and thus, their silicon nitride sintered bodies have a matrix (main phase) composed of the mixture of β-Si_3N_4 and α-Si_3N_4. Silicon nitride sintered bodies including α-Si_3N_4 phase are inferior in rolling fatigue life.

Note further that the present claims require a minimum long axis of 0.04 μm for the recited particles of titanium nitride. This value is above the 0.03 μm maximum preferred by Yoshimura et al '256, as reflected in Claim 2 therein. The presently-recited 0.04 μm minimum is above the maximum average particle size of 300 nm of Yoshimura et al '065. When the average size of the dispersed particles is too small, the rolling fatigue life cannot be improved.

Finally, Yoshimura et al could not have predicted the improved results for the presently-claimed invention, as supported by the comparative data of record.

In the Advisory Action, the Examiner finds, *inter alia*, that Claim 16 is outside the scope of Claim 1 because a roller bearing member is different from a ball member. In reply, Claim 16 recites a **rolling** bearing member, which is a species of ball member (emphasis added). Any further substantive findings in the Advisory Action have been addressed above.

For all the above reasons, it is respectfully requested that the above rejections be withdrawn.

All of the presently pending claims in this application are now believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to pass this application to issue.

Respectfully submitted,

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